No. 1157

Corporation of Madras.

B

Re: G. O. No. 893-M., Mis., dated 11th June 1919,

NOTE

BY

The Special Engineer, Corporation of Madras,

ON

The Madras Water and Drainage Schemes.

COLLEGE OF ENGINEERING
LIBRARY BOOK
15 MAY 1941
No.
GUINDY

J. W. MADELEY, M.A., M. INST. C.E.,
Special Engineer,
Corporation of Madras.

SPECIAL WORKS DEPARTMENT,
17*th November* 1919.

74235

TAMIL NADU ARCHIVES LIBRARY
ACC. No.
EGMORE, MADRAS-600 008

C
R
V2l1M, 6r' H
M19

CONTENTS.

Paragraph.	Description.	Page.
	Introductory letter	1 to 3
	NOTE.	
1	Introduction	5
2	General conclusions	5
3	Arrangement of Note	6
4	Waterworks. Present position and works still to be done ...	7
5	The importance of carrying out the complete drainage scheme ...	8
6	Present state of the drainage system	10
7	Result of defects in drainage system	11
8	Drainage work already done	12
9	Scope of Restricted Programme now nearing completion ...	14
10	Drainage work not included in Restricted Programme but urgently needed	15
11	Some details of areas outside Restricted Programme that urgently require drainage	15
12	Capital cost of works	19
13	Cost of water-supply maintenance	20
14	Cost of drainage maintenance	21
15	Comparative costs of drainage in Bombay, Calcutta, Colombo, and Madras	22
	ILLUSTRATIONS.	
	Photographs showing Sewered and Unsewered Streets	9
	Plan showing position at Madras Drainage on completion of Restricted Programme	Facing page 1

S. E. No. 1137/19.

CORPORATION OF MADRAS

Special Works Department,

RIPON BUILDINGS,

Madras, 17th November 1919.

FROM

J. W. MADELEY, ESQ., M. A., M. INST. C. E. M. AM. SOC. C. E., ETC.,

Special Engineer, Corporation of Madras.

TO

THE PRESIDENT,

Corporation of Madras.

Madras Water and Drainage.

As instructed by you, I have prepared, and enclose herewith, a note on the Madras Water and Drainage, with special reference to the points on which the Corporation is likely to require information before replying to the Government enquiry as to what it proposes to do with regard to the Comprehensive Schemes for the water-supply and drainage of the city.

2. The present position, and the works required, are described, and statements of the cost of executing the works, and of maintaining them, are given.

Very briefly the position is that, if Madras is to be made reasonably sanitary, the whole of the works included in the Comprehensive Schemes prepared by me, accepted by the Corporation, and sanctioned by the Government, are urgently needed, and should be constructed as soon as practicable. They were long overdue when I reached Madras in 1907. Since then a considerable amount of work has been done.

On the waterworks, the quantity has been doubled, the pressure trebled and the quality improved.

We now want further to increase the quantity of water available, and simultaneously to check waste, so as to enable a still greater pressure to be maintained, and above all, to improve the quality by constructing the necessary additional filters that were provisionally sanctioned in 1914.

3. The new drainage works remove large volumes of sewage which formerly poisoned air, food, and water in many thickly populated areas. The

new works collect it and deliver it to the North-east extremity of the Municipal area, where it is dealt with innocuously.

The lowering of the death-rate in the areas drained is satisfactory evidence of the improved sanitary conditions produced by these works. It must further be borne in mind that, without them, the old drainage system would have broken down completely. Many of the sewers would long ago have heen choked up with accumulations of silt, and most of the pumps would have ceased to work from old age and weakness. But for the new works, the conditions in the sewage-logged city would have become indescribable and unendurable. Death and disease would have scourged the inhabitants into action of some sort. Such are the evils that the works already in use have warded off ; those now in hand under the Restricted Programme will produce further great benefits, but many parts of Madras will still badly need sewers, if they are to be made as healthy as the inhabitants have a right to expect.

4. The plan accompanying the note shows how many areas are in urgent need of drainage. Madras has rightly decided on underground sewers, and these should be laid in all built-up areas. In other words, the Comprehensive Scheme should be carried out.

5. At present prices, which are far above those prevailing when the sanctioned estimates were prepared, the total cost of completing the water and drainage works will be about Rs. 125 lakhs.

The annual cost of maintaining the whole of the drainage works comprised in the Comprehensive Scheme is estimated at Rs. 6·66 lakhs as compared with the actual cost during 1918–19 of Rs. 5·39 lakhs.

The cost of waterworks maintenance (actuals 1918–19), is Rs. 2,26,000, but it is covered by receipts on account of water supplied.

These figures may appear high. To show that they are not excessive, I have obtained figures relating to the cost of construction and maintenance of the Drainage Works of Bombay, Calcutta and Colombo. They are given in tabular form on page 22 of the accompanying note. Here I may mention that the cost per head of the drainage system works out as follows :—

Bombay Rs. 42, Calcutta Rs. 50, Colombo Rs. 86, Madras Rs. 31. These figures show that Madras, despite its extensive area and high sub soil water, is drained more cheaply than any of the other cities mentioned. The costs of maintenance per head per annum are :—

Bombay Rs. 0·69, Calcutta Rs. 0·43, Colombo Rs. 0·87, Madras Rs. 0·69. If capital charges are added, they become respectively.—Bombay Rs. 1·95, Calcutta Rs. 1·93, Colombo Rs. 3·45, Madras Rs. 1·69.

6. It is not my province, nor am I qualified, to say how funds are to be raised to meet the cost. It has however been my privilege on some

previous occasions to represent the state of affairs to the Government, and perhaps for the benefit of the new Council I may be permitted to state that the Government have always shown their sympathy in the most practical manner, by making large grants when a good case, supported by facts and figures, has been presented to them. What the Government have done in the past they will doubtless do in the future.

7. The Local and Imperial Governments must appreciate the necessity of remedying the set-back that sanitation has suffered during the years of war. It would seem obvious, therefore, that advantage should be taken of the present favourable opportunity to put forward a strong case, so as to obtain our share of any funds that may be available with the Government, before they are distributed to others.

8. If the works are to proceed, the greatest possible use should be made of the staff now engaged in the Special Works Department, for should the staff be disbanded, and, after a time of doing nothing, fresh engineers obtained, the new men may find difficulty in understanding the reasons for the designs and methods of construction, which have been adopted as the result of the experience of years, and the city may have to pay a high price to buy experience for new men.

9. An early decision is desirable. My own term of service with the Corporation is drawing to a close, and, owing to the present uncertainty, my best men are trying to get work elsewhere. Some have gone, and others will doubtless leave before long, unless the Corporation makes it worth their while to stay.

These considerations lead to the conclusion that, to avoid a break, and to maintain continuity, the work to be undertaken in the future should be settled as early as possible, so that, as the Restricted Programme nears completion, a year or two hence, a start may be made on a definite and considered scheme of work by which the most urgent cases of insanitation may, so far as possible, be dealt with first, as part of the Comprehensive Scheme. Further, that the Comprehensive Scheme itself should be completed as early as practicable, for in no other way can Madras be rendered a tolerably sanitary city within a reasonable time.

I have the honor to be,

Sir,

Your most obedient servant,

J. W. MADELEY,

Note by the Special Engineer, Corporation of Madras on Work to be carried out on the Madras Water and Drainage Schemes already sanctioned.

G. O. No. 893-M. Mis., dated 11th June 1919, dealing with the Special Engineer's Progress Report No. 59, dated 5th April 1919, reads as follows :— **Introduction.**

ORDER :—

Recorded.

" 2. The Corporation is requested to report in due course whether it " proposes to take up the comprehensive schemes for the water-supply and " drainage of the city after the Restricted Programme is completed and, if so, " how the schemes are to be financed."

In what follows, an endeavour is made to supply information that will assist the Corporation to arrive at a decision on this important matter.

2. Briefly and broadly stated, the conclusion reached is that the Comprehensive Schemes for water-supply and drainage, approved by the Corporation and sanctioned by the Government, should be proceeded with, and finished with all practicable despatch, if Madras is to be made a reasonably sanitary city. **General Conclusions.**

At the time of the preparation of the two schemes 1911 and 1913 respectively they were generally admitted to be long overdue. During the years that have elapsed since then, the need for them has become more and more imperative.

Unfortunately, the cost of this class of work has increased considerably, so that, after the Restricted Programme has been finished, the cost of completing the works, compared with the sanctioned amounts, will be approximately as follows :—

—	Cost of completion of Water and Drainage Works.	
	As sanctioned.	As now estimated (1919).
	Rs. lakhs.	Rs. lakhs.
Water works	12·17	20·00
Drainage works	78·10	105·00
Total ...	90·27	125·00

S-2

The present cost of maintenance compared with the estimated cost on the completion of the Restricted Programme, and of the Comprehensive Scheme is as follows :—

—	Cost of maintenance per annum.		
	At present (1919).	As estimated on completion of.	
		Restricted Programme.	Comprehensive Scheme.
	Rs. lakhs.	Rs. lakhs.	Rs. lakhs.
Water works (including cost of water) ...	2·58	2·58	3·77
Drainage works	4·50	5·02	6·66
Total ...	7·08	7·60	10·43
Deduct			
Water works receipts	2·96	2·96	4·16
Amount required from taxation ...	4·12	4·64	6·27

The estimates of cost of maintenance of completed works do not include capital charges. They assume present (1919) cost of materials and labour, and also efficient, energetic, and economical supervision, together with the elimination of useless individuals. This may represent an ideal difficult of attainment, but its accomplishment is very important for a town with so small an income per head as Madras.

Arrangement of Note.

3. In the last paragraph the general conclusions are given. In the paragraphs that follow are set out the considerations that lead to the conclusions. Separate paragraphs are devoted to :—

(1) The Waterworks. Present position, and works still to be done.
(2) The importance of carrying out the complete drainage scheme.
(3) Present state of the drainage system.
(4) Results of defects in drainage system.
(5) Drainage work already done.
(6) Scope of Restricted Programme now nearing completion.
(7) Drainage work not included in the Restricted Programme, but urgently needed.
(8) The probable cost of the work, and of its maintenance. Comparative cost of water-supply and drainage in Bombay, Calcutta and Colombo.

4. The waterworks are much nearer completion than the drainage works. They therefore require less consideration, and will be dealt with first.

Waterworks. Present position and works still to be done.

The responsibilities of the Corporation with reference to water-supply are set out in Section 165 of the New Municipal Act (1919), in the following words :—

> "(1) The Corporation shall provide a supply of wholesome drink-"ing water within the city and shall erect sufficient stand "pipes, fountains, or other conveniences for the gratuitous "supply of water."
>
> "(2) The Corporation shall, as far as possible, make adequate provi-"sion that such supply is continuous throughout the year".

It is doubtful if the Corporation can claim that the requirements of the above section have been fully satisfied. On the other hand, their position would be rendered unassailable if the whole of the sanctioned works were completed, so as to ensure that all the water could be filtered, that the quality of the water be properly controlled by regular bacteriological examinations, and that, by systematic detection and elimination of waste, the greatest possible use is made of the water available. To this end, the following works are required :—

(1) *Additional filters.*—Sanctioned in 1914 are of vital importance, in order to end, as soon as possible, the necessity for adding unfiltered water—a practice that is universally condemned.

(2) A second work of great importance is the installation of a complete *Waste Water Detection Meter System*, in order to reduce waste both from the mains and from the houses. With the same object in view, *House Meters* should be fixed as soon as they can be obtained, for the monthly bill, which depends on the quantity of water measured by the meter, is an automatic check on waste.

(3) Another essential need, though one of maintenance, is a *Chemist-Bacteriologist* to examine the water, and to assist in solving the problems that are peculiar to the Madras supply.

(4) A work, which is not so urgent as those above mentioned, is a *Low-Level Elevated Tank* to provide more storage in case of break-down of the pumps or accident to the conduit, more especially the former. Such a storage tank would pay for itself in a few years, owing to the economy which would

result from the reduction of the head against which the pumps would have to work during the hours of low pressure in the distribution system.

(5) Finally the quantity of water available for Madras City should be increased without delay by *raising the Red Hills Full Tank Level and the Lowest Level of Irrigation* both by 18 inches as recommended by the writer in his Waterworks Report of 1911.

At present, possible shortage of water is feared every year. Both last year and this year, the supply was curtailed in consequence; in each case many complaints were received especially from those parts of the city that are furthest from Kilpauk.

Of the above mentioned works, (1) and (2) are included in the Comprehensive Scheme, and have been duly sanctioned by Government. The necessity for an Analyst is generally recognised. No estimates have been submitted for item (4).

Item (5) is delayed pending settlement of the question as to whether the cost of the necessary work should be borne by the Government or the Corporation. It is recommended that the Government be asked to carry out the work without further delay. The question as to who should pay for it can be settled later.

This is all that need be said concerning the Waterworks. The remainder of the note will be confined to the Drainage works.

The importance of carrying out the complete Drainage Scheme.

5. So long ago as 1875, it was laid down in England that "Every "local authority............*shall* cause to be made such sewers as may be "necessary for effectually draining their district..................." (P.H. Act. 1875-Sec. 15).

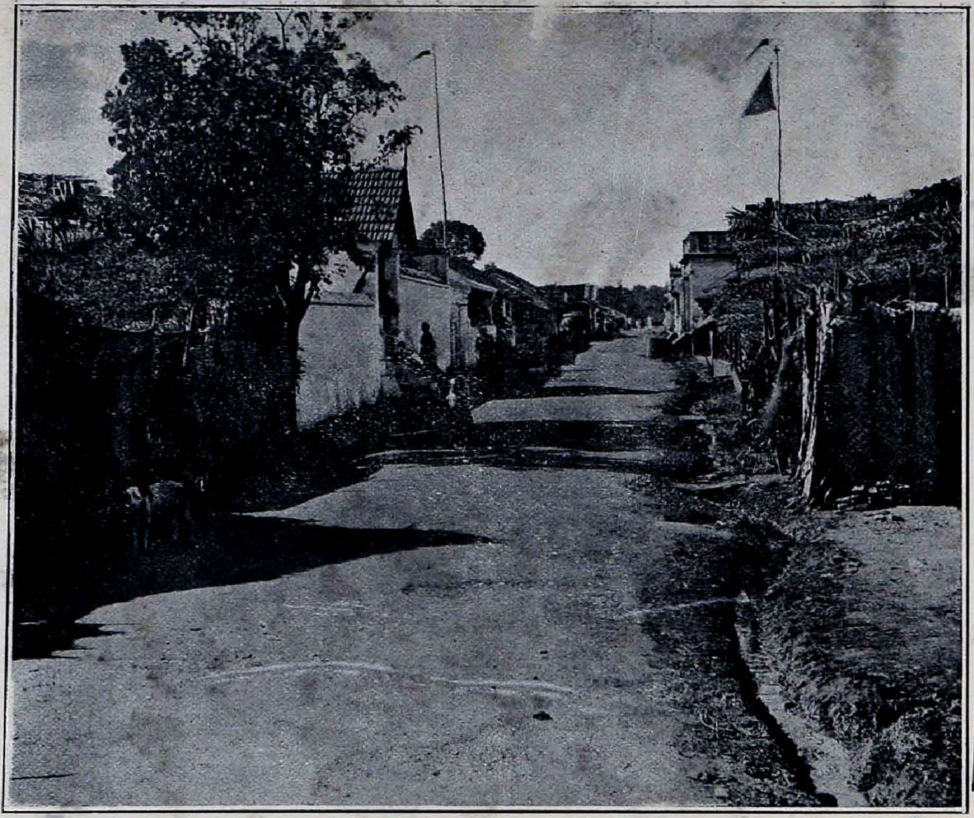
In the new Madras City Municipal Act of 1919, the same idea is expressed in Section 176 in the following words :—"The Corporation *shall*, so "far as the means at their disposal permit, provide and maintain a sufficient "system of public drains throughout the city."

It may unhesitatingly be stated that every responsible educated person recognises the paramount importance of good drainage, which, as the above two extracts indicate, is one of the essential requirements of a community.

The photographs on the next page indicate the difference between improperly drained and properly sewered streets.

The upper photograph of Toppai Mudaly Street, Tondiarpet, shows typical conditions in many streets before sewer laying.

On both sides of the road are earth drains, into which the house sullage water is discharged, to meander slowly on its way to so me neighbouring tank.— But little gets there. Most of it stagnates in elongated stench-producing cess-pools, where foul smelling gases are given off, and the liquid gradually soaks into the ground to contaminate the sub-soil water. These drains provide breeding places for countless mosquito-like flies which are conveyors of diseases such as cholera and dysentery. The photograph fails to convey a correct impression of the appalling conditions.



Compare them with those illustrated in the lower photograph which shows another street—Thumbu Chetty Street—in the same district, after sewer laying. Here all the faults enumerated above have been removed. The sullage is carried away quickly, and in a cleanly manner, to the sewers which convey it underground to the pumping stations, where it is sent on to the Farm right away from any closely built-up area.

Dr. Bentley, the Sanitary Commissioner for Bengal, in a recent report is stated to have said "that the elephantiasis mosquito, during dry weather, "was found breeding in large numbers in open drains and other collections "of foul water." The Chief Engineer to the Calcutta Improvement Trust writes: "it is impossible to create healthy conditions where any open drain "system obtains." This only confirms—if confirmation be needed—the views expressed by all the Sanitarians of Madras who are qualified to express an opinion on these matters.

Testimony to the improvement of health that results from sewering is overwhelming. The writer will confine himself to one quotation. Mr. W. J. Wallshow only this year reported that at Peterborough in England "they "had had a death-rate of 25 per thousand per annum, but with the con- "struction of new sewers, and the provision of water-closets they found the "death-rate reduced to 12 per 1000 per annum."

There can be no doubt in the minds of those who know about such things, that there is room for a similar improvement in the health of Madras, for the drainage of Madras is admittedly unsatisfactory.

The Main Drainage Scheme provides a remedy that has been approved by the Corporation and sanctioned by Government. No alternative has been put forward. Undoubtedly therefore it should be carried out if the requisite funds can be obtained—a question outside the scope of this note.

The extent to which drainage work is required, and the cost of providing it have now to be considered.

Present state of the Drainage System.

6. In previous reports and notes by the writer the dangerous condition of the drainage system has been stated. But, even though it involves the re-statement of frequently repeated facts, it is necessary to refer to it once again.

Except for the areas served by the New Drainage Works, the condition of the City as regards drainage is truly deplorable.

Through faulty design, the old drainage system is defective from its start at the house, to its end at the Sewage Farm.

To begin with, it was designed to deal with one fourth to one third of the sewage which flows to it. Then nearly every part of the system is defective thus:—

At the *house* silt and storm water are admitted in large quantities, and the house connections are improperly made.

74235

Should there be any delay in carrying out the comprehensive scheme, a large expenditure will have to be incurred very early in altering house connections in Mylapore, Chintadripet, Krishnampet and other areas, if the total choking up of the old sewers in these areas is to be prevented.

The *old sewers* are many of them too small and all of them too flat.

The *pumps* are altogether inadequate to pump the sewage of the areas with which they are intended to deal. Their capacity should be three to four times greater than it is.

Further, they are old, worn out, frequently break-down, and cannot be made to work efficiently much longer.

Result of defects in Drainage System.

7. As a result of these defects, the old sewers are continually silting up. Owing to the pumps being unable to keep down the sewage, it is impossible to clean the sewers properly, and silting continues until the sewers are completely choked, so that no sewage can flow through them. Breakdown of the drainage system then takes place with overflow on to the streets, into tanks, nullahs, the Cooum river, and the canal. Large volumes of sewage are now overflowing continuously every day.

There is already considerable local break-down, and to keep the system going, a number of sewers have had to be taken up and relaid with new pipes. For instance, the old 12 inch sewer in Veeraraghava Mudaly Street, Triplicane, was recently found to be completely choked, and numerous smaller sewers in the Ice House Road, Napier Park and Mylapore areas have been found in a similar condition, and have had to be replaced by new pipes. Only last August, the 12-inch main sewer in West Cooum River Road collapsed in two places. The concrete pipes, of which the sewer is made, were found to be completely decomposed at the top, and further collapses are inevitable. In the Comprehensive Scheme, this sewer is not retained. But if the Comprehensive Scheme is not proceeded with, the whole sewer will have to be relaid.

These instances are typical of the general local failure of the old sewers. Complete break-down over large areas of the city is an imminent danger, which causes the Engineers much anxiety.

So much was this danger appreciated that the Senior Assistant Special Engineer was engaged for some months in studying the conditions carefully to ascertain what could be done to keep things going. He submitted a report, from which the following extract is taken :—

" In conclusion I may state that the condition of the existing drainage in " all the areas will not be satisfactory until the whole scheme as set out in " your Main Drainage Report is carried out. The sooner money is forth- " coming the better as the present state of affairs cannot last indefinitely.

" For the benefit of the non-technical man it should be pointed out that " when no overflow of sewage is seen on roads, it does not follow that the " drainage is satisfactory. No sewer is satisfactory if continually surcharg- " ed. No pumping station is satisfactory if it cannot deal with the maximum " rate of flow of sewage. These two satisfactory conditions cannot be " attained in Madras until the whole scheme is completed."

The above remarks do not refer to the areas served by the new drainage works. Lest it may be thought that no useful drainage work has been carried out, the next paragraph will contain a list of some of the drainage works executed, and the paragraph following will mention the works included in the Restricted Programme, which is now approaching completion.

Drainage work. already done,

8. Much good work has already been done, and more still is in hand and will be effective when the Restricted Programme has been completed. Amongst other works already done may be mentioned :—

(1) *The removal of Kelly's Scent Bottle.*—A nuisansce so great in magnitude as to make Madras a by-word throughout the Empire.

(2) *The removal of the Rayapuram* nuisance caused by the discharge of sewage into the sea immediately north of the harbour.

These two nuisances were dealt with by the construction of the Law College and Rayapuram Pumping Stations and the laying of a new large cast iron pumping main to the Sewage Farm. By these means, the sewage is now removed from the most densely populated part of the city, and discharged over the Farm, 3 miles to the north.

(3) *The drainage of the first three divisions*, which, in consequence, have been rendered much more healthy. The number of houses now in course of construction in these divisions is pleasing testimony to the appreciation of the improvement effected. For some years before the completion of the drainage works, more and more houses were becoming tenantless, the population was decreasing, and the death rate was notably higher than in any other part of the city. Now all this is changed. " The main streets, along which sewage formerly " flowed in black sluggish streams, are now dry and clean."* The population is increasing, and the death-rate relative to other areas has fallen.

(4) A complete system to *irrigate the Sewage Farm*, including a large elevated open channel along the west boundary, to supply sewage to large underground pipes across the farm, which connect with open distributary channels from which the sewage flows over the land.

* Mr. Molony in Corporation of Madras Administration Report, 1917-18-p vi.

(5) *The drainage cf Triplicane,* where an immense improvement in sanitary conditions has resulted from the construction of the new Gravitation Main right through the area, and the laying of the sewers tributary to it. Anyone, who remembers the conditions of the net-work of lanes at the north-east corner two years ago, cannot fail to be struck with the great improvement that has been effected.

(6) *The construction of the Vepery Pumping Station,* though only a temporary measure, has very greatly improved the condition of Periamet—one of the very worst in the city. Here the flooding of the streets with sewage, which could not get away, was of daily occurrence in practically every street in the area. Now it occurs only after heavy rains.

(7) *Re-engining DeMellow's Road Pumping Station* has greatly improved the sanitary condition of a large portion of Vepery.

(8) The laying of a *new street sewer in Wall Tax Road,* and an *intercepting sewer in China Bazaar Road,* have removed the great fouling of the Buckingham Canal by continuous sewage overflow from this area. Since the works were completed, overflow into the canal occurs only when, for some reason such as heavy rain, it is impossible to cope properly with the sewage flowing to the Law College and Rayapuram Pumping Stations.

(9) The design, and construction of *special apparatus and typical methods of applying good European practice to Madras conditions.,* e. g. *First-class Drainage*—Opthalmic and Royapettah Hospitals, Ripon Buildings. *Second-class Drainage*—Kalyani Hospital. *Third-class Drainage*—Thousands of houses throughout the city.

Flushout latrines—in many places.

Night-soil Depots—Krishnampet, etc. *Apparatus for dealing with silt etc.—Silt Catcher Buckets, Stormwater Separators,* and Silt Raisers.

Much of this work, together with the staff trained to execute it, has been transferred to the Works Department.

(10) *Anti-Malaria and Stormwater Drainage Works,* by which the numerous swamps of Purasawakam have been drained, and the flooding of East Georgetown, West Georgetown, North Triplicane, South Triplicane, and Egmore has been dealt with.

(11) *Many minor works*—too numerous to mention individually, which have removed local cases of insanitation, such as existed in Mount Road and in the neighbourhood of the Slaughterhouses.

Unfortunately the public memory is very short in such cases, and probably the fact that the nuisances ever existed has been forgotten by now.

Scope of Restricted Programme now nearing completion.

9. In addition to the works mentioned in the last paragraph, the following will be executed when the Restricted Programme is finished :—

(i.) The construction of three new pumping stations, one each at :

Ice House Road.
Napier Park.
Purasawakam.

(ii.) The re-engining of DeMellow's Road Pumping Station.

(iii.) The construction of a new cast iron pumping main from the new Purasawakam Station.

(iv.) The construction of the following three Gravitation Mains.

One through the Napier Park Area.
One through the Purasawakam Area.
One from the end of the Purasawakam Pumping Main to the Sewage Farm.

(v.) The construction of networks of intercepting sewers, street sewers and house connections in Georgetown, Triplicane and Vepery, and also in many particularly insanitary areas, to remove many cases of very unhealthy conditions, and to relieve the gross pollution of the river Cooum and the Buckingham Canal.

The above mentioned works are nearing completion. When finished they will cut out most of Vepery and Purasawakam from the old cast iron main, which should then be capable of carrying the sewage pumped into it. The new Napier Park, Ice House Road, and Purasawakam pumps will be able to deal with all the sewage and a proportion of rainfall. The new gravitation mains will carry the sewage to the pumping stations and will very much reduce the pollution of the Cooum and the Buckingham Canal, and the stagnation of sewage in the Purasawakam Tanks. The new sewers laid at proper gradients, and provided with apparatus to exclude silt, will, with moderate care, prove efficient, and overflow on to the road surfaces should cease.

These works will produce a very material improvement in the sanitary condition of Madras. Large quantities of sewage, which now meander along

tortuous drains until the liquid is evaporated, or gradually soaks into the ground to contaminate the sub-soil water, will be removed right away from the centres of population. Improvement in the health of many densely populated areas will certainly follow.

Further drainage will still remain to be done. Its imperative importance will be considered in the next paragraph.

Drainage wor not included i Restricted Pr gramme but urgently neede

10. The Restricted Programme was drawn up at the beginning of 1916, when financial stringency and the need of concentrating all possible effort on work connected directly or indirectly with the war, made it necessary to postpone as much work as possible.

The Restricted Programe works included those necessary to secure the greatest benefit from the work already wholly or partly constructed, to render more efficient the present overburdened system, and to remedy the worst cases of insanitation.

It may fairly be claimed that these objects will be secured, but, as stated on page 2 of the writer's Restricted Programme Report "Many works "other than those estimated for in the Restricted Programme are essential "before the drainage can be considered satisfactory. Until a complete "comprehensive scheme is carried out, such as that described and estimated "for in the writer's Madras Main Drainage (1913) Report, it is useless to "expect the health of Madras to become that of a normally healthy city."

The work to be done after the completion of the Restricted Programme will probably be best understood by reference to the map accompanying this note. The whole of the coloured areas are included in the Comprehensive Scheme. The areas that will be drained, and the work that will be in use when the Restricted Programme is finished, are shown in red.

The whole of the remaining coloured areas require draining. The areas where drainage is already urgent, are coloured green, but before the works in these green areas can be finished, the areas coloured yellow will also be in crying need of drainage ; *i.e.*, the whole of the Comprehensive Scheme will be required.

The areas drained by the old drainage system are hatched. It will be seen that nearly all the hatched area is coloured green, showing that nearly all the old sewers urgently need to be taken up and relaid. The areas coloured blue are those where it is proposed to retain the old sewers for a time, though in all probability they will eventually have to be abandoned and new sewers substituted.

Some details areas outsid Restricted F gramme tha urgently requ drainage.

11. Some account will now be given of the areas where drainage works outside the Restricted Programme are urgently required. The numbers refer to those on the plan accompaning this note.

TAMIL NADU ARCHIVES LIBRARY

Tondiarpet Drainage Area.

I. *Puduvannarpet* to the West of the Sewage Farm is a small closely built up area. At present the sullage flows to the East and soaks away into the low lands. The method of draining this area is dealt with in paragraph 183 of the Special Engineer's Tondiarpet Report.

Georgetown Drainage Area.

II. *Central and South Georgetown.* A very closely built up area. It is drained by open drains which contain large quantities of silt and rubbish. The open drains are connected to underground sewers by imperfectly designed silt pits with gratings which block up shortly after cleaning. This results in the accumulation of sewage, which stagnates for long periods, giving off offensive gases lowering to the vitality. The stagnation of sewage during night time results in surcharging of the sewers in the mornings, for when the coolies clear the gratings they liberate a very large quantity of sewage which, added to the maximum house discharge that takes place at the same time, causes a maximum flow with which the sewers and pumps cannot deal adequately. The remedy is to sewer the area as is being done in the remainder of Georgetown.

When the area has been sewered in accordance with the comprehensive scheme, the sewage will not accumulate but will be carried away immediately ; many of the side drains will then be done away with, though some will be retained for rainwater, but these will be covered and provided with proper gulley traps and silt pits.

Purasawakam Drainage Area.

III. *South-east Purasawakam.* The same remarks apply as to Georgetown, except in the Periamet area, where there are faulty old sewers which will have to be relaid.

The *Main Intercepting Sewer* conveying the sewage to DeMellow's Road Station is in a very bad condition and is much silted up. It should be replaced by a new intercepting sewer leading to the new Purasawakam Station. Similarly, the *Purasawakam Gravitation Main* should be continued to Langs Garden Pumping Station. These two works, which are included in the Comprehensive Scheme, will cut out a considerable quantity of sewage from the old pumping main, which will then be capable of taking all the sewage from South Madras.

IV. *South-west Purasawakam.* At present this area is drained by earth ditches and masonry drains many of which are broken down. A large building development has recently taken place in this locality which may now be considered as closely built up. The sewage finds its way along open drains which eventually discharge into the Otteri Nullah which, in consequence, is made very foul in dry weather. The area should be sewered and the sullage taken into the new drainage system.

Napier Park Drainage Area.

V. *Chintadripet* is drained by the old system, but the sewers are badly silted, and there is continual overflow of sewage into the river Cooum, and often on to the roads, especially in Cox Paracherry. Frequent obstructions occur in the sewers, and the area is now the worst of those drained by the old works. The only remedy is to sewer it in accordance with the Comprehensive Scheme.

VI. *North-west Triplicane.* The same remarks apply as to V.

VII. *West Triplicane.* A very densely populated area, drained by open drains. These discharge into old masonry drains which in turn deliver their contents to the sewers. A large quantity of stormwater and silt conveyed by these drains makes the maintenance of the sewers a matter of great difficulty, and the insanitary condition of the side drains renders re-sewering a matter of urgency.

Langs Garden Drainage Area.

VIII. *North Egmore.* This area is now closely built up. It is at present drained in an unsatisfactory manner by side drains, and should be sewered at an early date.

IX. *East Egmore.* Drained by the old system. The sewers are badly silted up, and the concrete pipes of which they are made, are eaten away by the action of sewer gas. The area requires re-sewering at an early date to prevent complete break down.

Spur Tank. Should a new General Hospital and a Medical College be erected on the Spur Tank as proposed, then a new main sewer will be required to take the sewage to the Langs Garden Pumping Station.

Graemes Road Drainage Area.

X & XI. *Nungambakam Village, Kutti Paracherry, and Teynampet Paracherry.* Have a few side drains discharging into earthen channels where the sewage partly evaporates and partly soaks away. In some streets there are cess pools requiring daily attention.

XII. *Thousand Lights Paracherry, and Amir Garden Paracherry.* In this area have been laid a few sewers which lead to Ice House Road Pumping Station. The distances are however so great that the sewers have had to be laid almost flat and are continually silting up. They should be taken to the proposed new Graeme's Road Pumping Station as provided for in the Comprehensive Scheme.

To deal with the sewage of this area (X, XI and XII), it is necessary to construct Graeme's Road Pumping Station, lay the pumping main and gravitation main to Langs Garden, and re-construct the Langs Garden Pumping Station to enable the pumps to deal with the increased sewage flow and remove it from the old cast iron pumping main. All these are provided for in the Comprehensive Scheme.

Ice House Road Area.

Areas XIII & XIV are mostly provided with sewers under the old system, but many of them are too small. All of them are laid at gradients that are too flat, and are badly silted up. A number of sewers made of cement pipes have already had to be relaid, because they were eaten away by the action of sewer gas, and many more will have to be relaid at an early date. The small area coloured blue between areas XIII and XIV is one in which it is hoped, by means of improved pumping, and improved house connections, to utilise the existing sewers. Only experience can prove whether this hope is justified.

Edward Elliots Road Area.—XIV. A.—This area is similar to the Graeme's Road area in having a number of Paracherries—coloured green on the plan—which require drainage. By the construction of the gravitation main from Edward Elliots Road Pumping Station to Ice House Road Pumping Station, the built up area on Barbers Bridge Road can be sewered.

North Mylapore Area.

XV. This area is sewered by old sewers which are too small, laid too flat, and are badly silted up. The sewers are in a very bad state owing to the number of openings that have been made to remove obstructions from the pipes. The area requires re-sewering at proper gradients as provided for in the Comprehensive Scheme.

South Mylapore Area.

XVI. The extension of Mylapore in a southerly direction has resulted in the built up area being extended beyond the range of the existing pumping station, and a new (Mylapore South) Pumping Station, as provided for in the Comprehensive Scheme, is needed. This station will be connected to new sewers which are required to drain the area.

Capital Cost of works.

12. The following statement shows for the water and drainage works the sanctioned expenditure, the expenditure up to the end of the last financial year (31st March 1919), and the estimated amounts required to complete the Restricted Programme and the Comprehensive Schemes respectively.

Particulars.	Water-supply.	Drainage.	Total.
	Rs. lakhs.	Rs. lakhs.	Rs. lakhs.
Estimated cost of sanctioned works.	68·09	146·47	214·57
Expenditure on sanctioned works completed to 31—3—1919 ...	55·66	45·16	100·83
Estimated cost of sanctioned works not executed on 31—3—1919 ...	12·43	101·31	113·74
Deduct still to be expended on Restricted Programme	0·26	23·21	23·47
Sanctioned estimated cost of works not executed on completion of Restricted Programme ...	12·17	78·10	90·27
Increase due to increased prices of materials 33·1/3 per cent. for drainage and 60 per cent. for water-supply say	7·83	26·90	34·73
Total amount required to complete Comprehensive Schemes after completion of Restricted Programme	20·00	105·00	125·00

COST OF WATER-SUPPLY MAINTENANCE.

Comparative Statement of (1) Present Cost, (2) Cost after completion of Comprehensive Scheme.

Particulars.	Present cost (1919).		Cost after completion of Comprehensive Scheme.	
	1		2	
	Rs.		Rs.	
Red Hills Tank Roughing Filters, &c.—				
Establishment	3,216	933	3,528	1,044
Labour		2,283		2,484
Filter Beds and Conduit.—				
Establishment	17,688	1,632	25 040	1,680
Labour		1,598		3,360
Materials etc.		14,458		20,000
Analysis of water.—				
Establishment		...	2,210	1,920
Labour		...		290
Pumping Station, Kilpauk.				
Establishment	1,13,077	7,925	1,21,916	9,830
Fuel, Stores, etc.		1,02,362		1,09,186
Labour		2,790		2,900
Distribution.—				
Repairing Fountains, hydrants, pipes, &c.		...		...
Establishment	55,672	16,908	78,092	26,412
Materials		20,640		21,500
Labour		15,412		26,580
Allowance		1,779		2,100
Purchasing and fixing hydrants		933		1,500
Head Valves (Kilpauk Shaft).—				
Establishment	1,096	203	1,254	270
Labour		893		984
Waste inspection and prevention.—				
Establishment	3,745	2,817		
Labour				32,000
Materials		928		
Contingent		16,989		20,400
House services.—				
Labour		...		...
House meters.—				
Repairing Meters	14,534	8,477	40,000	10,000
Purchasing and fixing meters		6,057		30,000
House meter maintenance.—				
Labour				
Allowance		...		8,000
Overhead charges and contingencies.		...		13,560
Total ...		2,26,017		3,46,000
Receipts.				
Water bills		2,71,000		3,50,000
Sundry receipts		15,000		25,000
Meter rents		10,800		41,000
Total ...		2,96,800		4,16,000

COST OF DRAINAGE MAINTENANCE.

Comparative Statement of (1) Present cost, (2) Cost after completion of Restricted Programme, (3) Cost after completion of comprehensive scheme.

Particulars.		Present cost (Actuals 1918-1919).	Cost after completion of Restricted Programme.	Cost after completion of Comprehensive Scheme.
		1	2	3
			Figures are those of Restricted Programme Report plus 20 per cent. for increased cost of labour and ma'erials.	
		Rs.	Rs.	Rs.
UNDERGROUND DRAINAGE.				
Pumping Station, Labour	2,40,751	37,412	2,92,000	3,08,304
" " Fuel etc.		1,26,632		
" " Repairs		49,376		
" " Stationery ..		2,111		
" " Establishment ...		24,200		
" " Allowances ...		1,020		
Sewer Cleaning Labour ...	90,876	36,063	1,20,000	2,23,200
Main " " ...				
House Drainage " ...				
Tondiarpet Drainage " ...				
Repairs to Sewers and Syphons ...		30,393		
Establishment		22,800		
Allowances		1,620		
Contingencies		14,849	...	44,496
Total for Underground Drainage ...		3,46,476	4,12,000	5,76,000
HEALTH DEPARTMENT CHARGES.				
Hire of coolies	1,92,781	54,324	90,000	90,000
Maintenance of bullocks		1,01,950		
" carts		17,071		
Establishment and allowances ..		19,436		
		5,39,257		
Deduct excess charges say... ...		89,257		
Total ...		4,50,000	5,02,000	6,66,000

Note.— Health Department Charges.

In addition to charges for coolies employed in side drain cleaning, a debit is at present made against drainage of one-third of the whole cost of maintenance of bullocks and carts including Establishment. This is considered excessive, and only actual estimated charges are given in columns 2 and 3—an allowance being made for maintenance of Storm Water Drains.

COMPARATIVE COSTS OF DRAINAGE IN BOMBAY, CALCUTTA, COLOMBO AND MADRAS.

74235

—	Bombay.	Calcutta.	Colombo.	Madras.
	Rs. Lakhs.	Rs. Lakhs.	Rs. Lakhs.	Rs. Lakhs.
CAPITAL CHARGES.				
Capital expenditure on Drainage	220	200	170	46·50
Anticipated future expenditure.	200	250	10	108·50
Total expenditure past and contemplated	420	450	180	155
Present population of areas drained	10,00,000	9,00,000	2,10,000	5,00,000
Cost per head ... Rs.	42	50	85·71	31
Length of Sewers and Storm water drains (in miles) ...	277	500	127	240
Cost per mile of drain Rs.	1·52 Lakhs.	0·90 Lakhs.	1·42 Lakhs.	0·65 Lakhs.
Extent of drainage area in square miles	16	15	9	15
Cost per square mile drained Rs	26·25 Lakhs.	30 Lakhs.	20 Lakhs.	10·33 Lakhs.
MAINTENANCE CHARGES.				
Total per annum ...	6·89 Lakhs.	3·84 Lakhs.	1·83 Lakhs.	3·46 Lakhs.
Cost per head per annum Rs.	0·69	0·43	0·87	0·69
Approximate charges for interest and amortization of capital ... Rs.	1·26	1·50	2·58	1·00
Total approximate annual charges per head Rs.	1·95	1·93	3·45	1·69

Thompson & Co., Printers, Madras.

TAMIL NADU ARCHIVES LIBRARY EGMORE, MADRAS-600 008